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AUTHOR Gibson, Susan McCloud
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ABSTRACT

The cause of music consonance perception is not known, but consonance has been defined by both physical and perceptual characteristics. This study tested the extent of differences in interval perceptions and preferences in a non-musically trained group of adults. The independent variables of frequency range, condition of presentation, and harmonic intervals were judged for magnitude of preference. Results suggest that consonance preferences do not change when tones are heard in other frequency ranges or presentations. The findings also indicate that consonance preference may be a perceptual process that is not dependent upon frequency range or condition of presentation. Results of the study further imply that processes for aesthetic appreciation differ and are less demanding than aural discrimination processes. Charts and tables are included. (JHP)

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JUDGMENTS OF PREFERENCE ON SIMULTANEOUS SOUNDED BITONAL FREQUENCIES IN THE MONAURAL AND DICHOTIC CONDITIONS

by

Susan McCloud Gibson

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Judgments of Preference on Simultaneous Sounded Bitonal Frequencies in the Monaural and Dichotic Conditions

Susan McCloud Gibson

Consonance has been defined by both physical and perceptual characteristics. Helmholtz (1895) defined consonance as those intervals whose ratios of frequency were small numbers. These he termed "simpler." Stumpf (1898) defined consonance by the perception of "fusion." Both of these theories relied on the physical characteristics of the two simultaneously sounded tones. The judgment of preference on simultaneously sounded bitonal frequencies has also been considered to be a measurement of consonance in tonal stimuli. Research by C.C. Pratt (1933) showed that there was a bimodal distribution of preference judgments on the harmonic intervals within the chromatic octave. Research by Gibson and Perrott (1986) using a different method and different stimuli showed a similar bimodal curve. Other preference judgments have been dependent upon frequency range and cognitive factors. In this experiment, frequency range is varied and there is little or no cognitive factor. Preference judgments are made on intervals whose ratios are known and the condition of presentation is analyzed for both monaural and dichotic hearing. The goal is to determine the extent of differences in interval perception due to varying conditions of a non-musically trained sample population.

The independent variables of frequency range, condition of presentation and simultaneously sounded frequencies (harmonic intervals), are judged for magnitude of preference by nonmusically trained adults. The frequency range was tested under three levels of the fundamental tone: 110 hz., 293.66 hz., and 739.99 hz. The fundamental tone was paired with one of the twelve ratios which are a logarithmic scale of the octave relationship of 2:1. The ratios paired with the fundamental tone produce a sound consistent with the harmonic intervals heared in an equally-tempered Western music scale. The ratios were then presented in either the monaural--both tones to one ear--or dichotic --one tone to ear ear--condition. All combinations of the tones were presented in a random order five times per subject (n-18) through headphones. All stimuli were sinus waves (pure tones).

Each response was indicated through the use of a grid on the computer screen by locating an appropriate location (most preferred near the top through least preferred near the bottom). The subjects responses were recorded numerically for ease of analysis. The data was analyzed using a 3 x 2 x 12 ANOVA. Post hoc testing using the Newman-Keuls test showed the extent of the variance. A comparison with roughness judgments was analyzed.

Results showed that there was a significant difference in all main effects and the interaction between frequency range and condition of presentation. This indicates that although preferences are different between the intervals, these preferences do not change when heard in other frequency ranges or the other condition of presentation. The bimodal curve was present at each frequency range and in each condition. The intervals were grouped into eight categories according to significant differences. These are compared with both roughness judgments and music theory classifications.

The data indicated that preference is based upon more than the simplicity of ratios and fusion. Middle-valued ratios were most preferred. The data also indicated that there is a consistent preference of each interval throughout the varying conditions of the experiment; therefore, preference of the interval is not based upon frequency range or condition of presentation. This research showed that preference of the interval can now be regarded as a perceptual process which is separate from roughness judgments and not dependent upon frequency range or condition of presentation.

INTRODUCTION

Consonance is associated with preference or lack of discord which causes tension. Although aesthetic preference of simultaneously sounded bitonal frequencies is the basis and guide for the development of Western music history, theories of consonance perception are conflicting. Specifically, the cause of consonance perception is not known.

The octave is perceived as a basis for all major systems of musical scales (Ward, 1954), but learning (Farnsworth, 1926) and cultural differences (Cazden, 1945; Lundin, 1947) can affect the perception of consonance. Science has debated whether the cause is due to the ratio of frequencies of the two tones (Helmholtz, 1895), the perceived fusion of the two tones (Stumpf, 1898) or preference which may be based upon other characteristics (Pratt, 1933). Western music theory, in this century, has adopted a formal analysis of the intervals. This classification scheme constitutes another definition of consonance or dissonance.

E. G. Boring (1942) stated that any theory of aesthetics is ultimately involved in the question of tension reduction. Tension, when defined by the complexity of two ratios, supports the theory of Helmholtz in interval preference. His theory says that the more complex a ratio, the more dissonant its sound. Dissonance must be assumed to mean lack of preference in this case. Research by C.C. Pratt (1933) using paired comparisons, and R. Plomp (1966/1929) have shown that the most preferred intervals are those with ratios of frequency in the middle-valued range. Pratt's research was substantiated by a similar experiment (Gibson and Perrott, 1986) using different stimuli and methodology. A model of optimal complexity has been found to be consistent with an intermediate amount of stimuli (Heyduk, 1975). Therefore, tension reduction and a positive relationship with preference are not experimentally substantiated.

Processing ability has influenced the degree of preference. In a cross-cultural study of human perception Maher (1976) argues that there is a similarity in perception although music cultures differ. The only difference between Indians and Candadians was that Indians did not feel that a minor second should resolve to the tonic. Another aspect of processing involves frequency range. Frequency range has been explored and has had an impact upon preference of intervals. Farnsworth and Voegelin (1926) observed that preference for individual intervals was consistent near the center of the piano range. Vitz (1972) reported that subjects preferred tones of intermediate frequency (400-750 Hz). Because the singing and speaking range are in the middle of the piano, adaptation to human speech might be involved with preference of frequency perception.

Cognitive factors have also been shown to influence preference judgments. Dorfmann and McKenna (1966) have shown that there are preferred levels of cognitive uncertainty. Munsinger and Kessen (1964) have substantiated this in their study of preference and cognitive uncertainty. Knowledge (Fisher, 1951) and repetition of stimuli (Farnsworth, 1926; Kelly, 1961; Valentine, 1914) have been shown to increase preference for dissonances. Larson (1971) found that novelty, not repetition of music, was found to increase preference for musical compositions. Although familiarity increases preference, the extent of boredom vs. novelty is an additional issue to be explored.

The preference of intervals may be influenced by unrecognized psychological processes that can express themselves in mathematics or symmetry as well as music. A preference study comparing geometrical shapes and harmonic intervals showed a strong correlation (Huntley, 1970). It was found that the Major 6th was most preferred. Because the Major 6th is significantly the same as the octave in smoothness perception, the concept of preference due to smoothness is supported.

Preference may incorporate two differing aspects. In two studies of interval consonance (Valentine, 1913; Pratt, 1921) it was found that judgments of dislike were consistent with the "dissonant' variables in music theory, but the preferred intervals were not consistent with the most consonant in music theory. Perhaps preference should be defined by consistent decisions with dissonance, but varying decisions with consonance.

Although the aesthetic judgment is considered to be stable (Pratt, 1956) and motivated by tension reduction, individual judgments have been shown to vary greatly. Additionally, preference can vary between subjects because of experience; whether experience is induced experimentally or as the result of specific professional training (Munsinger and Kessen, 1964). Therefore, musicians and nonmusicians must be considered separately.

In this experiment, twelve intervals (I) are presented in two conditions of presentation (C) and in three frequency ranges (F). It is the goal of this experiment to determine the differences, if any, in interval preference in a nonmusically trained sample population. The aesthetic judgment of magnitude of preference is chosen as the dependent variable for this experiment. It is expected that optimum preference will be consistent with levels of middle ratic complexity and middle frequency range. By varying the conditions under which two tones are judged, one hopes to elucidate the understanding of consonance and preference. "Factual data, the product of scientific investigation, when correctly used, will help evaluate and develop better music education processes and practices" (Chalmers, 1977, p. 34-35).

METHOD

Subjects

Eighteen volunteer adults who were not musically schooled were used as subjects. Age ranged from 18-59. Subjects were given a pre-test to determine their ability ot hear the range of frequencies presented and two pre-trials to facilitate their use of the apparatus. Subjects were treated in accordance with A.P.A. ethical guidelines (American Psychological Association, 1981).

Apparatus

Stimuli were simultaneously sounded bitonal frequencies of pure tone (sine waves) which were randomly generated and delivered on an Amiga computer (Commodore Corporation). This computer was used because of its stereo sound generation capabilities. All tones were calibrated at 60 db SPL and channeled through an impedance matching transformer to headphones (Telephonics, TDH 49). The fundamental was delivered to one ear and the second tone was randomly delivered to either ear creating the independent variable of condition of presentation : monaural or dichotic. The three fundamental frequencies were the following: 110 Hz., 293.66 Hz., 739.99 Hz. The second tone was one of the twelve ratios of the fundamental tone consistent with the harmonic intervals of the chromatic scale. This corresponds to an increase of the fundamental and a resulting ratio in the following manner: 1.0667=33:31; 1.125 = 9:8; 1.2 = 6:5; 1.25 = 5:4; 1.33 = 4:3; 1.406 = 44:32; 1.5 = 3:2; 1.6 = 8:5; 1.67 = 5:3; 1.8 = 9:5; 1.875 = 15:8; 2.0 = 2:1. For further clarification, see Table 1. The experiment tool place in an ordinary closed room.

Procedure

The subject was seated in front of the microcomputer and asked to adjust the headphones comfortably to avoid any distraction or uncomfort during the test. The subject was then presented with the question: "Do you know what any of the harmonic intervals sound like?" Only data from negative resonses to this question were used in this experiment. The subject was then given a pre-test of the range of frequencies and was asked to respond about the ability to hear each frequency. If all responses were positive, the subject was presented with written instructions regarding the operation of the microcomputer mouse and the placement of the cursor on the screen to indicate judgments. The experimenter was not present for data collection to avoid experimenter bias (Green, 1971).

The cursor of the microcomputer was moved by the subject to a place within a given rectangle on the monitor screen. The vertical dimension on the microcomputer screen was labeled and represented a continuum from very much liked to very much disliked. After the judgment was made and the mouse moved to an appropriate location of the rectangle, (It was found that discrimination improved in conditions in which tactile movement was used. - Radke, Jacoby and Goedel, 1971) the subject responded by pressing the left button of a microcomputer mouse (Tactile judgments were not significantly different from independent pitch judgments - Copeland, 1964). The next simultaneously sounded bitonal frequency or harmonic interval was sounded when the left button of the mouse, indicating the judgment, was pushed. The judgment was recorded as a number corresponding to the closest unit of a 300 unit scale. There were five replications for each of the combined conditions resulting in 72 conditions and 90 judgments per cell. Trials were completely randomized. The 18 subjects utilized the method of magnitude estimation in their responses.

RESULTS

Main Effects and Interactions

A three-way (3 x 3 x 12) ANOVA was used to analyze the independent variables of increase of the fundamental for the second tone (I, n=12), fundamental frequency (F, n=3), and condition of presentation (C, n=2). The results of the ANOVA revealed at the .01 alpha level that the main effects and the interaction between frequency and condition were significantly different. All other interactions were not significant.

Post-hoc Testing

Post hoc testing using the Newman-Keuls test revealed that the preference of the intervals varied and were significantly different from each other consistent only with the dissonant intervals in Western music theory (least preferred). The most preferred intervals were those of 'middle to simple (small numbered ratios)' complexity with the preferences similar to Western music consonances except in the interval of the octave (2:1). The octave was not the most preferred, but judged in the middle range of the intervals. Although the categories of preference judgments of intervals were eight, the categories of consonance in Western music are three. See Table 2.

In the preference judgments, the middle fundamental frequency was significantly different from the other two frequencies and was more preferred. Both the high and low frequency ranges are therfore less preferred than the one whihc is most similar to the normal speaking range. Preference judgments showed that the dichotic condition was more preferred than the monaural condition. This is interesting in that most natural stimuli would be in the monaural form -- physically mixed before entering the ear canal. Thus, additional beats created when physical mixing occurs are not preferred.

The fundamental frequency by condition of presentation (F x C) interaction of the preference judgment showed that each combination of frequency with condition of presentation was significantly different from each other. The two monaural conditions were least preferred. Next preferred were the lower fundamental frequency conditions, then the dichotic conditions. Most preferred were the middle frequencies. The fact that only the F x C interaction was significant indicates that frequency range and condition play a larger role in the preference of harmonic intervals than might be anticipated by the practicing musician.

It is important to note the fact that there were no significant interactions which included the independent variable of 'interval'. This indicates that a specific interval is preferred similarly regardless of the condition of presentation or the frequency range in which it is presented. This principle is included in Stumpf's 1898 explanation of dissonance. Additionally, the data support the concept that people prefer intervals of middle complexity and of middle frequency range -- a principle related to Helson's theory of adaptation-level.

A Comparison with Judgments of Roughness

The dependent variable of preference was compared to the results of an identical study which had a dependent variable of "roughness." The two dependent variables were compared only for those main effects and interactions which were significant in both studies. These comparisons include the main effects of interval, frequency range, and condition of presentation as well as the interaction of frequency range by condition of presentation (F x C).

The comparison of the variable of interval (I) indicates that the judgments for each interval are similar for the middle values, but the extremes are perceived differently. Roughness has greater magnitude in the extremes than does the judgment of preference. Figure 1 shows that both preference and smoothness vary in the same direction for each interval, although there is more tolerance in preference for the degree of roughness. This is important to note because both the preference and roughness judgments partially support music theory definitions of consonance.

Fundamental frequency (F) comparison is shown in Figure 2. Although preference is significantly different only for the middle frequency range; roughness is perceived much more in magnitude, at the lower frequency range than the other ranges presented. Therefore, one sees different effects in consonance judgment based on differing criteria. This supports the hypothesis that preference and roughness are not similarly perceived and should not be used to similarly define harmonic consonance.

The condition of presentation (C) is significantly different for its two levels -- monaural and dichotic. There is both less preference and greater roughness for the monaural condition. See Figure 3. The physical combining of two tones affect basilar membrane movement. This combination is the basis of the explanation of dissonance due to critical bandwidth. In addition to the distortion of the physical mixing of two tones (cancellation and summation), there may be distortion due to interference on the basilar membrane. This would be expected but the difference between the two conditions are not as great as could be anticipated.

The combination of fundamental frequency by condition of presentation (F x C) is graphed in Figure 4. Again, one sees the large affect of the lower frequencies on the perception of roughness. The middle frequencies are, again, most preferred but are of middle roughness in magnitude. The high and low frequencies are less preferred but roughness is much greater for the lowest frequencies.

As one considers the results of these data in regard to both dependent variables, the question of the definition of the harmonic interval remains the primary focus. The similarity of preference judgments for the individual interval suggested that the interval has a unique quality which relates to a degree of both pleasantness and smoothness. The fact that the upper frequency range is significantly different from the lower range in roughness, but is not significantly different for preference judgments support the uniqueness of the criteria by which consonance is judged. The data are not consistent with any one theory of harmonic interval consonance/dissonance perception.

DISCUSSION

The goal of this experiment was to determine the extent of preference differences when judging the interval in a variety of auditory conditions. The independent variables of interval and frequency were chosen purposely to coincide with typical musical input. These intervals sounded like those heard by hitting two tones within the same octave on a piano -- but without additional harmonics. The frequency range presented in this experiment was located in the middle range of the piano and includes the speaking and singing ranges. The lack of cognitive training in interval perception was intended, but a similar study is needed using trained musicians.

The elimination of confounding variables was maximized in this experiment. To eliminate confounding with harmonics, only pure tones were used. The stimuli were generated, collected and analyzed by computer processes. All conditions were replicated five times and randomly presented so that the effect of the order of presentation would not bias the data. After a verbal explanation of the experiment, a hearing test, and two trials to become familiar with the equipment, the experimenter left the room until the subject finished the entire number of trials (360). Experimental error was minimized.

Culturally influenced biases were minimized in the independent variable of condition of presentation. The dichotic condition is not heard in typical audition. The only drawback in dichotic perception could occur if a person, who is hard of hearing, did not allow the good ear to receive the fundamental tone. This was not true for the subjects in this experiment. Each subject was given a hearing test, and forewarning biases based upon condition of presentation were not present. One must conclude that the judgment was made by nonmusically schooled normal-hearing adults. Problems reported with regard to methodology included sequential sounds influencing judgments; and preconditioned associations of individual sounds (e.g. telephone sounds).The design and methodology showed allowed for clear, unbiased analysis by the researcher. Having defined the expectations and conditions of the experiment, one must compare the results with expectations of established theories and experiments.

That the intervals were similarly perceived throughout varying frequency ranges supports the work of Boomsliter and Creel (1961). The theories of Helmholtz and Stumpf were not supported in their entirety. Only Stumpf's principle of consistent interval perception throughout varying frequency ranges was supported. The results of the preference study are important in that they show that interval judgments do not change with varying range and conditions of presentation. The extremes of range are less preferred. The monaural condition of presentation is less preferred, and intervals significantly vary in preference according to eight ranked categories. Additionally, the data supports the bimodal curve observed in other studies of interval preference (Pratt, 1933; Gibson and Perrott, 1986).

It is important to remember that although the intervals of middle complexity were significantly more preferred, the judgments for any interval were not extreme in magnitude. Because the judgments did not significantly change for frequency range or condition of presentaion indicates that the judgments of interval preference are fairly stable. It is important to note that the order of preference for intervals is identical, with the exception of the octave, to the order of the intervals in Western music theory.

Because both extremes of the frequency range (F) were significantly different from the middle frequency range, subjects preferred the middle frequencies over both extremes. This supports Helson's adaptation-level theory which states that people prefer stimuli of middle tension. The work of Dorfmann and McKenna (1966), Heyduk (1975), Munsinger and Kessen (1964) and Vitz (1972) also support this hypothesis. Within a given frequency range, there are differences in preference due to each interval. These results are consistent with a part of the theory of Stumpf who advocates that interval consonance (fusion) does not differ for varying octaves.

The preference of the dichotic condition (C2) over the monaural condition (C1) indicates either that binaural beats are preferred over frequency beats, or frequency beats cause more distortion than binaural beats. An explanation might be that the frequency beats cause more interference, are more confusing, or are more rough, and thus are less preferred. Although theoretically, either preference for binaural beats or lack of preference for frequency beats, the author would support the latter because of her own aural experience.

The interaction between fundamental frequency and condition of presentation (F x C) was analyzed in post-hoc testing and indicated that extremes of frequencies primarily, and physical interference, secondarily, have large negative impacts upon the preferences of harmonic intervals. Combining both conditions, it is found that the middle frequency range was most preferred. This indicates that either preference is for any middle range, or that the middle frequencies used in this experiment are preferred. Although the literature supports the first choice, the fact that the speaking range is within this middle range and does not appear to be distorted, gives strong support for the second option. The monaural condition of presentation, in all frequency ranges, was less preferred. The fact that the monaural condition is significantly perceived as rougher supports the idea that roughness is less preferred.

Consonance often brings to mind the idea of that which is pleasant or preferred. This author asserts that musical consonance is influenced by a lack of distortion (smoothness) and an optimal complexity or tension level of the interval. Because both of these seemingly unassociated criteria give credence to the word "consonance," the judgments of both preference and roughness needed to be compared. The results of the analyses show that they are indeed different phenomena. When compared with judgments of roughness, differences in preference are fewer than those of roughness perception using similar stimuli and non-intervallically trained people. This suggests that the processes for aesthetic appreciation are different and less demanding than those processes of aural discrimination. A subsequent study of roughness and of musicians further elucidates the aesthetic problem of harmonic consonance.

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Table I

Systems of designation for the harmonic interval.

MUSICAL INTERVAL	INTERVAL	INCREASE	CENT EQUIVALENCE
Perfect Unison (P1)	1:1	0	same tone
minor second (m2)	33:31	1.067	100
Major second (M2)	9:8	1.125	200
minor third (m3)	6:5	1.2	300
Major third (M3)	5:4	1.25	400
Perfect fourth (P4)	4:3	1.33	500
Tritone (TT)	44:32	1.406	600
Perfect fifth (P5)	3:2	1.5	700
minor sixth (m6)	8:5	1.6	800
Major sixth (M6)	5:3	1.67	900
minor seventh (m7)	9:5	1.8	1000
Major seventh (M7)	15:8	1.875	1100
Perfect octave (P8)	2:1	2.0	1200

Table 2

Ranked comparison of roughness and preference judgments of interval with Western music theory dissonance.

Preference judgments = 8 categories from least preferred to most preferred.

LEAST PREFERRED							MOST PREFERRED
M7	m2	M2 m7	TT	P8	m6 M6	M3, m3, P4	P5
1	2	3.5 3.5	5	6	7.5 7.5	10 10 10	12

Roughness judgments = 4 categories from roughest to smoothest.

MOST ROUGH									LEAST ROUGH
m2 M2 M7	m6 TT	m7 P4 M3 P5 m3	M6	P8
2 2 2	4.5 4.5	8 8 8 8 8	11.5	11.5

Western music theory = 3 categories from dissonance to consonance.

MOST DISSONANT								MOST CONSONANT
m2, M2, M7, m7, TT	m3, M3, m6, M6	P4, P5, P8
3 3 3 3 3	7.5 7.5 7.5 7.5	11 11 11

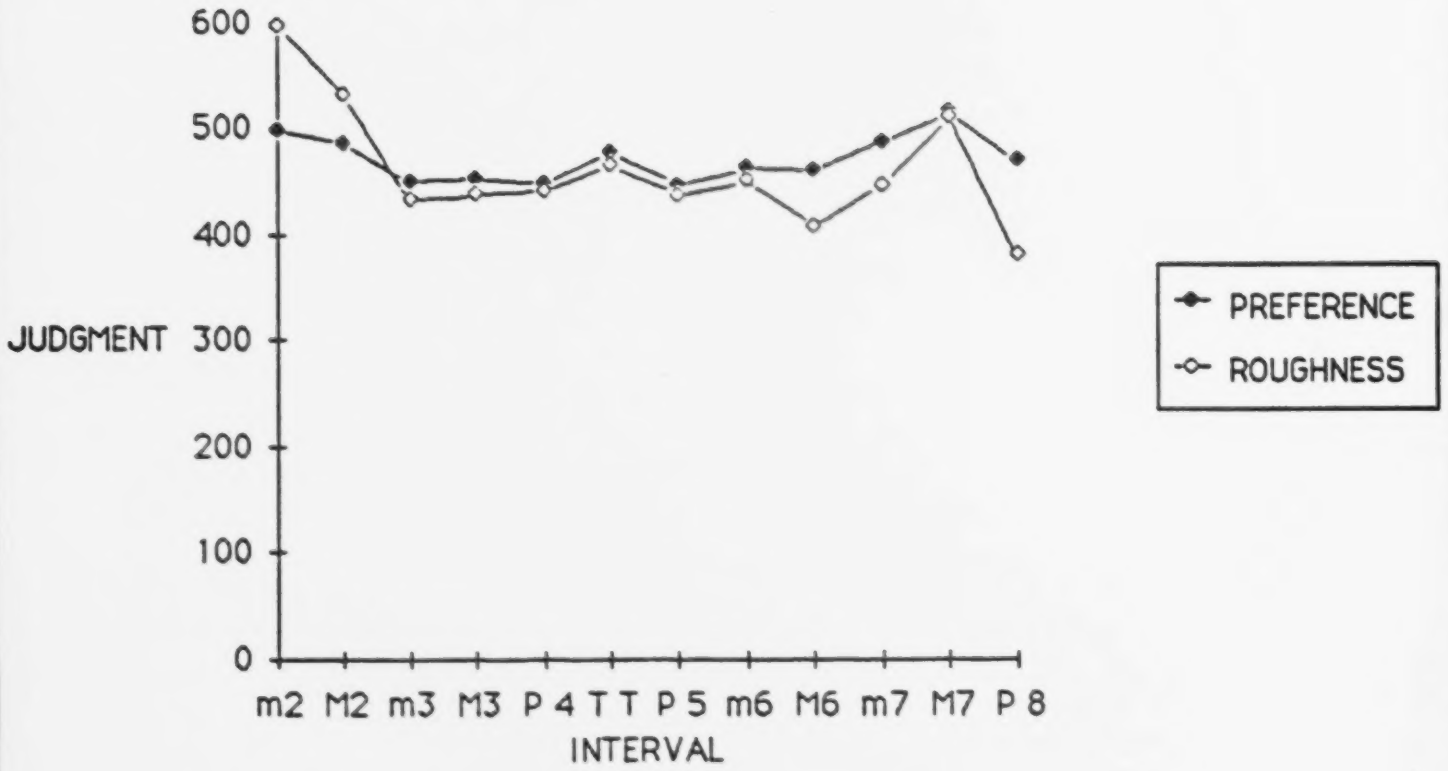

600
500
400
JUDGMENT 300
200
100
0
m2 M2 m3 M3 P 4 T T P 5 m6 M6 m7 M7 P 8
INTERVAL
PREFERENCE
ROUGHNESS

Figure 1

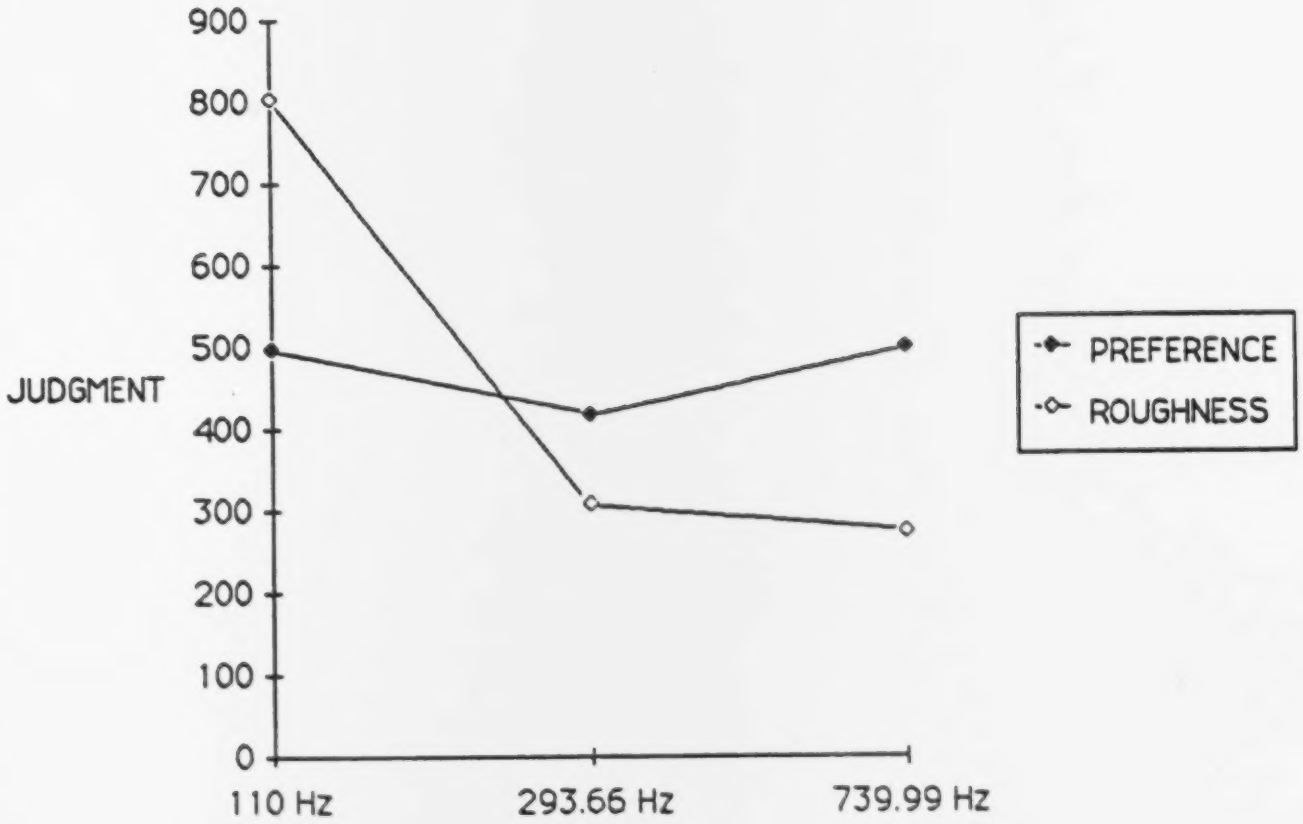

900
800
700
600
500
400
300
200
100
0
JUDGMENT
110 Hz
293.66 Hz
739.99 Hz
PREFERENCE
ROUGHNESS

Figure 2

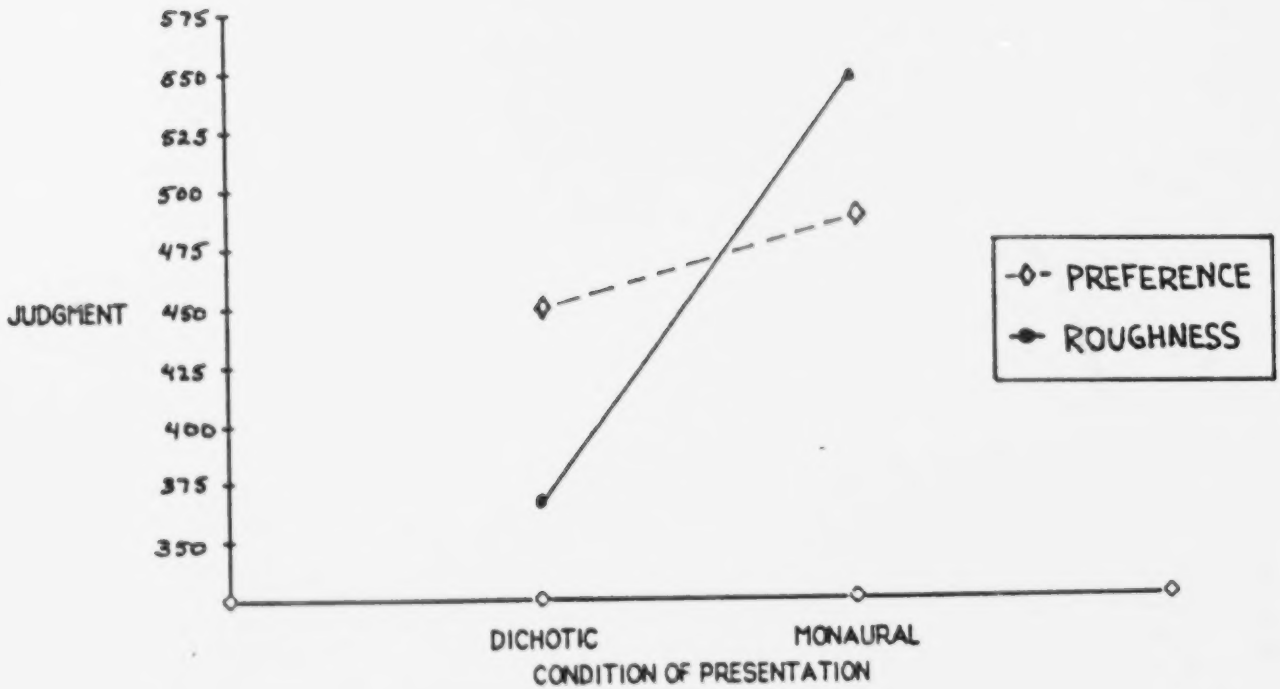
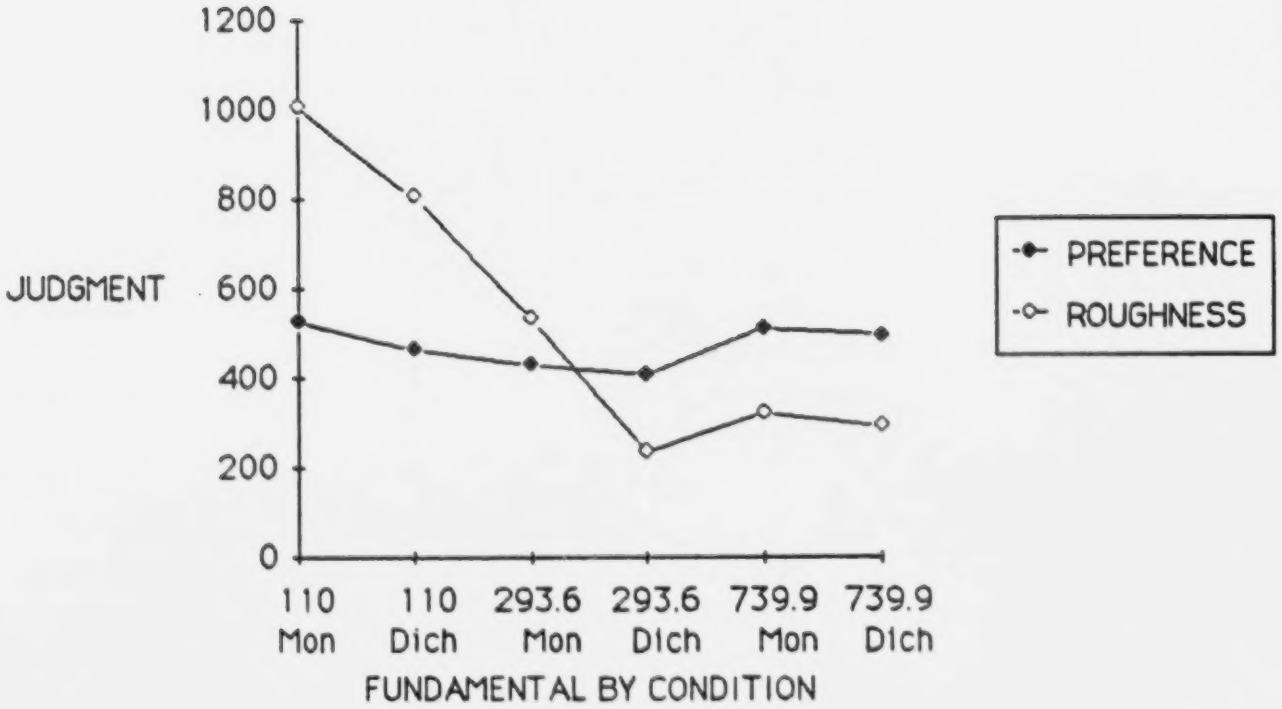

575
550
525
500
475
450
425
400
375
350
JUDGMENT
PREFERENCE
ROUGHNESS
DICHOTIC
MONAURAL
CONDITION OF PRESENTATION

Figure 3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0
110 Mon
110 Dich
293.6 Mon
293.6 Dich
739.9 Mon
739.9 Dich
FUNDAMENTAL BY CONDITION
PREFERENCE
ROUGHNESS

Figure 4

Source	Sum of Sq.	df	Mean Sq.	F critical	F observed
FUND.FREQ.	1886433.6	2	943216.82	3	85*
RATIO	512582.71	11	46598.428	1.855	4.2*
CONDITION	452032.11	1	452032.11	3.84	40.4*
F X R	359876.28	22	16358.013	1.545	1.47
F X C	165921.67	2	82960.836	3	7.48*
R X C	64405.87	11	5855.079	1.855	0.53
F X R X C	101917.68	22	4632.622	1.545	0.42
ERROR	13,582,263	1224	11,096.62		
TOTAL	17125432	1295			

APPENDIX TABLE 1 - ANOVA ON PREFERENCE

Major 7	minor 2	minor 7	Major 2	Tritone	Octave	minor 6	Major 6	Major 3	minor 3
515.91	499.25	487.32	485.43	476.81	468.31	461.29	458.71	453.64	449.07
	16.66	28.59	30.48	8.62	47.6	54.62	57.2	62.27	66.84
		11.93	13.82	22.44	30.94	37.96	40.54	45.61	50.18
			1.89	10.51	19.01	26.03	28.61	33.68	38.25
				8.62	17.12	24.14	26.72	31.79	36.36
					8.5	15.52	18.1	23.17	27.74
						7.02	9.6	14.67	19.24
								7.65	12.22
								5.07	9.64
									4.57

Perf. 4	Perf. 5	Crit.Val.
447.85	445.71	
68.06	70.2	23.98
51.4	53.54	23.71
39.47	41.61	23.39
38.36	39.72	23.03
28.96	31.1	22.62
20.46	22.6	22.12
13.44	15.58	21.58
10.86	13	20.85
5.79	7.93	19.95
1.22	3.36	18.68
	2.14	16.5

APPENDIX TABLE 2 - PREFERENCE — INTERVALS

	Fundamental Frequencies		
739.99	110	293.66	Crit. Val
498.97	496.72	416.64	
	2.25	82.33*	9.33
		80.08*	8.25

	Condition of Presentation		
	MONAUR	DICHOTIC	Crit. Val
	488.6	45.19	
		35.17*	6.73

APPENDIX TABLE 3 - PREFERENCE -- FUNDAMENTAL FREQUENCY AND CONDITION OF PRESENTATION

Least Preferred					Most Preferred	
110 MON	739.99 MON	739.99 DICH	110 DICH	293.66 MON	293.66 DICH	CRIT. VALUE
528.51	506.59	491.36	464.93	430	403.28	
	21.92	37.15	63.58	98.51	125.23	15.28
		15.23	41.66	76.59	103.31	14.74
			26.43	61.36	88.08	14.1
				34.93	61.65	13.21
					26.72	11.67
	ALL ARE	SIGNIFICANT	LY DIFFEREN	T		

APPENDIX TABLE 4 - PREFERENCE -- FUNDAMENTAL FREQUENCY BY CONDITION OF PRESENTATION